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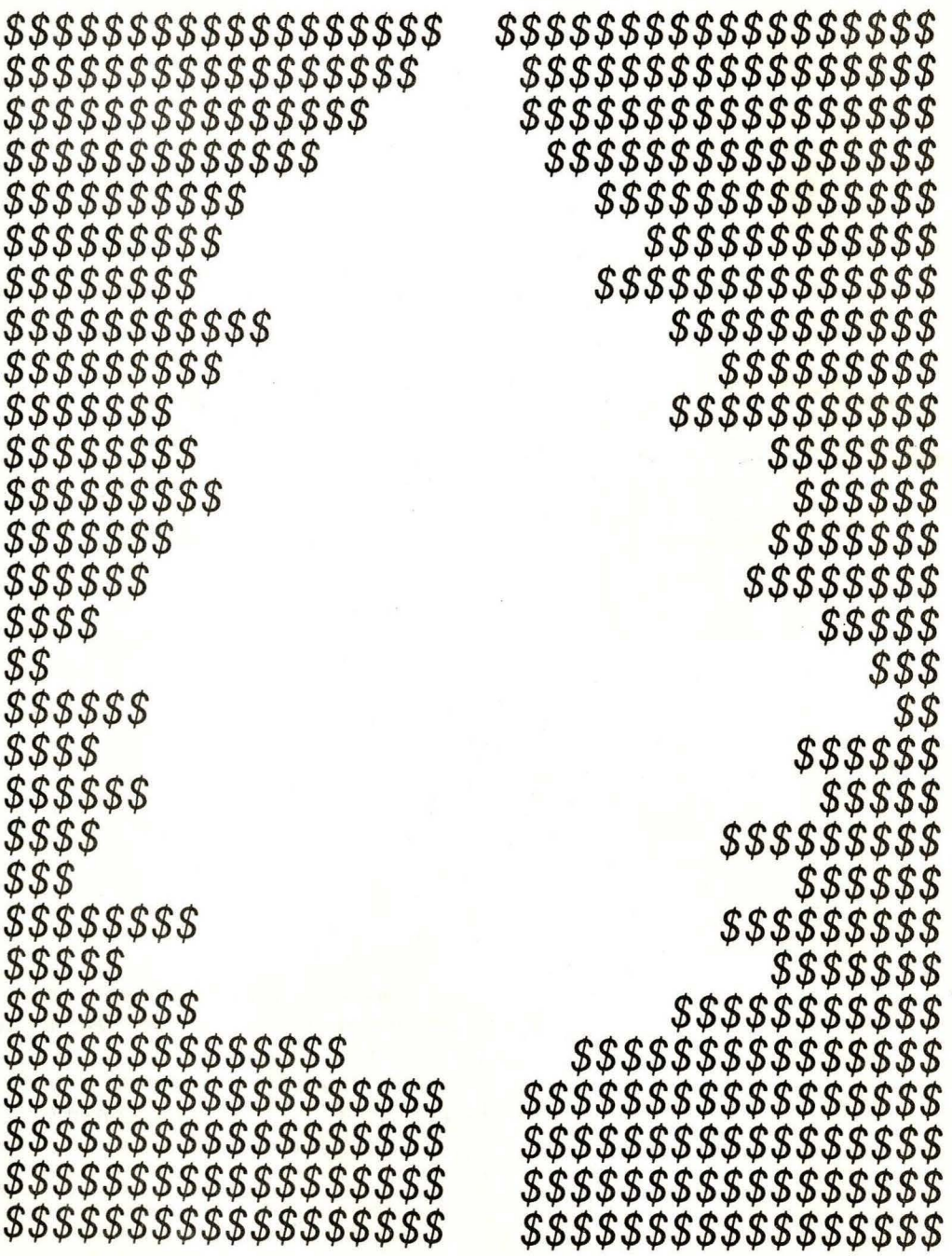

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A NEW LOOK AT RED PINE FINANCIAL RETURNS IN THE LAKE STATES

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Red pine plantations or natural stands make up only 2-½ percent of the Lake States' commercial forests and contain less than 1 billion cubic feet of volume. But wood users as well as land managers like its versatility. Red pine's relatively high strength makes it desirable for girders, joists, studs, and trusses. And because the trees are generally straight with little taper and are easily treated with preservatives, they make ideal poles, posts, pilings, and cabin logs. In addition, red pine is used with other softwoods to manufacture pulp (Kallio and Benzie 1977). As a result, red pine commands higher prices than any other Lake States' softwood species.

New evidence in support of this popular species comes from recent analyses of growth and yield data from established plantations. That study indicates that red pine yields are much greater than previously estimated (Lundgren 1981).

Although the new biological evidence about red pine yields is promising, what about the financial evidence? Which existing and potential red pine sites warrant investment and how should they be managed to achieve the best financial performance?

Using the new biological growth information and recent management and harvest cost estimates, in this note we suggest answers to these questions using two investment criteria: The soil expectation value (SEV) and the internal rate of return (IRR)—both before taxes.[1] For both criteria we calculate a "return to landowner" that assumes that the landowner pays for the harvest as for any other service. This permitted us to ignore stumpage prices, but required us to explicitly examine the impact of all costs to grow, harvest, and transport red pine on our two criteria.

[1] *Definitions of the soil expectation value and internal rate of return are found in most standard forest economics text such as Gregory (1972). A rationale for the use of each criteria is found in Bradley and Lothner (1983).*

ASSUMPTIONS

Although many different market scenarios are possible, this note assumes that both red pine saw logs and chips can be sold. For stands whose average diameter equals or exceeds 9 inches, we assume that saw logs are separated before chipping the remaining tops and smaller stems. Stands averaging less than 9 inches are chipped entirely using slightly smaller, less expensive equipment. We assume high utilization—much higher than currently practiced. However, there is strong evidence to expect higher utilization in the future when plantations established now will be cut.

The management strategies we analyzed and report on are similar to those used by Lundgren (1981). Analyses were made for three site indices—60, 70, and 80 for several combinations of three factors: (1) survival densities of 400, 600, and 800 trees per acre—the number of trees surviving 5 years after planting, (2) residual basal area after thinning of 60, 80, 100, and 120 square feet per acre, and (3) rotation ages of from 50 to 95 years.

We assume the plantations are established by planting 2-year-old seedlings in a square spacing. Subsequent management includes chemical release at 3 and 6 years. Release is followed by thinnings at intervals of not less than 10 years; the first thinning is no earlier than 20 years after planting and only if (1) the height to a 3-inch top diameter inside bark is at least 17 feet, (2) average stand diameter is at least 5 inches, and (3) the thinning removes at least 25 percent of the total basal area.

Establishment and management cost estimates were gathered from industrial and public land managers, researchers, and some published material. As expected, cost estimates vary, resulting in questionable analyses when single cost values are used. However, this problem can be partially solved by performing sensitivity analyses to show the effect of different cost assumptions on SEV.

Bare land for growing red pine in the Lake States is assumed to cost $75 per acre and will be sold for the same price at the end of one rotation. Light mechanical site preparation is assumed to cost $75 per acre, and could include brush raking, disking, and barreling. Planting costs are 11¢ per tree; 5¢ for stock plus 6¢ for the labor to plant it. But because we assume that only three-fourths of the seedlings survive, the established cost per tree is 14.5¢. Chemical release in years 3 and 6 is assumed to cost $30 per acre for each application. A general administration cost of $1.10 per acre as well as the property tax of 60¢ per acre will be charged each year.

Our harvest and transport cost estimates are based on system productivity data assembled from the literature as well as from recent research dealing with full tree chipping and saw log sorting (Bradley, *et al.* 1980, Hypes 1979, and Sibal 1981). Although harvest costs per hour for the two systems are assumed fixed, average stand diameter, basal area, and the proportion of sawtimber effect harvest costs per cunit. Stand diameter, however, is the most important factor. For example, when only chips are produced from a stand with 90 square feet of basal area and an average stand diameter of 9 inches, harvest cost is $15.30 per cunit. Yet, harvest cost declines to $5.70 per cunit (a 64 percent reduction) if the average diameter increases to 18 inches while basal area remains 90 square feet per acre.

Transport cost is also extremely important, amounting to 25 to 50 percent of delivered costs. We assume that each stand lies 25 miles from the mill and transport costs $6.30 per cunit. Sale preparation and sale administration are assumed to cost $81 per acre for each thinning and $106 per acre for a clearcut.

Prices for sawtimber and pulpwood were gathered from Lothner *et al.* (1982). We assume that chips will return $55 per cunit and sawtimber will return $90 per cunit FOB mill.

RESULTS

Assuming a 4-percent discount rate, SEV increases three times ($268 to $842 per acre) when site index increases from 60 to 80. Yet optimum initial stocking is constant for all sites examined (400 surviving trees per acre). However, optimum basal area after thinning does increase from 80 square feet per acre for site index 60 to 100 square feet for site index 70 and 80 (table 1). Higher site indices also lower optimum rotation age slightly, but varying the age of final harvest even 10 years, plus or minus, has little effect on financial outcome.

The discount rate chosen strongly affects SEV. For the site index 60 analyses, all SEV's are positive with a 4-percent discount rate but negative with a 6-percent discount rate. Optimum rotation age also occurs earlier with higher discount rates.

Results are similar regarding IRR, which increases a whole percentage point as site index increases from 60 to 70 and from 70 to 80. Similarly, optimum initial stocking and optimum basal area after thinning do not change with site. Finally, optimum rotation age also shows little change as site increases, when IRR is the criterion (table 2).

Just how sensitive are either SEV or IRR to changes in initial stocking level and residual basal area? For site index 60, if one increases initial stocking from 400 to 600 trees per acre, SEV can decline as much as 28 percent and IRR can decline as much as 10 percent (table 3).

Our sensitivity analysis to identify how each cost or revenue factor affects financial performance indicated that the most important factors are product price followed by harvest and transport cost. Relatively small changes in either of these two factors have a large impact on the financial performance of any management strategy.

Table 1.—*Red pine management strategies achieving a maximum soil expectation value at a 4 percent discount rate on three sites for a saw log and chip market*

Site index	SEV	Rotation age	Initial stand density	Residual basal area	Total output	Mean annual increment
	$/acre	*Years*	*Trees/acre*	*Ft²/acre*	*Cunits*	*Ft³/acre/y*
60	268	65	400	80	71	110
70	520	65	400	100	101	156
80	842	60	400	100	114	190

Table 2.—*Red pine management strategies achieving a maximum internal rate of return on site indices 60, 70, and 80 for a saw log and chip market*

Site index	IRR	Rotation age	Initial stand density	Residual basal area	Total output	Mean annual increment
	Percent	*Years*	*Trees/acre*	*Ft²/acre*	*Cunits*	*Ft³/acre/y*
60	5.0	55-65	400	80	59	107
70	6.0	60	400	80	83	138
80	7.0	55	400	80	93	169

DISCUSSION

With current Lake State prices for saw logs and pulpwood, growers can apparently earn real returns of 5, 6, and 7 percent on red pine sites 60, 70, and 80, respectively. Again, by real rates, we mean that if inflation occurs, all prices and costs will undergo the same relative changes. Soil expectation values for these three sites are $268, $520, and $842 per acre.

We must emphasize that these results are only indicative. Although much of the data are very good, especially the red pine growth data, no one really knows what future prices will be, yet prices have the most important effect on the outcome. Although the harvest and transport cost data are speculative, they reflect the realistic range of costs expected.

An important point to consider is that the optimum levels of initial stocking, basal area after thinning, and rotation age suggested in our analysis, differ dramatically from practices recommended in the past. This difference occurs primarily for two reasons. First, we assume no real red pine price increases over the rotation. Most previous financial analysis of red pine have assumed that prices will increase from 1 to 3 percent per year relative to costs. The effect of these more optimistic price and cost assumptions is the same as assuming much more rapid growth rates. And, of course, if one can expect volumes to be worth more, the longer one waits, rotation ages will necessarily be higher than those suggested here. Second, our harvest cost assumptions reflect a very strong inverse exponential relation between tree diameter and cost. Our recommended initial stocking level of 400 trees per acre, while producing slightly less total volume over the rotation than 800-1,000 trees per acre, results in much larger trees than previously recommended initial levels. Tree diameters are about twice as large at the lower initial stocking recommended here (Lundgren 1981) and cost very much less to harvest per unit volume.

Thus, many factors affect the future financial success of red pine investments. And it is important that managers keep abreast of them all.

Table 3.—*SEV and IRR for red pine, site index 60, saw log and chip market*

Initial stand density	Basal area after thinning (ft²/acre)			
	60	80	100	120
		SEV at 4%		
		Dollars per acre		
400	222	268	263	249
600	229	235	236	192
		IRR		
		Percent		
400	4.9	5.0	4.9	4.8
600	4.8	4.8	4.8	4.5

[1]Definitions of the soil expectation value and internal rate of return are found in most standard forest economics text such as Gregory (1972). A rationale for the use of each criteria is found in Bradley and Lothner (1983).

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A new look at red pine financial returns in the Lake States. Res. Pap. NC-246. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station; 1984. 4 p.

Describes the financial performance of red pine on site index 60, 70, and 80 lands by using new yield evidence and up-to-date cost and revenue assumptions. Best combinations of initial stocking, residual basal area after thinning, and rotation age are identified for two different financial criteria: soil expectation value and internal rate of return.

KEY WORDS: Soil expectation value, internal rate of return, *Pinus resinosa*, economics, timber management.

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